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(54) **Controlled environment transportation of respiring comestibles.**

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Description

The present invention relates to improvements in and/or relating to the carriage of comestibles and/or plants whether cut or not (hereinafter simply "comestibles") and in particular to an apparatus applicable thereto including containers and related means and methods.

In New Zealand Patent Specification No. 205453 (US patent 4642996, Australian patent 567966 and other equivalents thereto) there is disclosed a system utilising shipping containers whereby the respiring comestible is loaded into a container, the container is then sealed sufficiently to ensure that less oxygen from ambient air can diffuse into the container than is required for respiration by the comestible, flushing the container (preferably with a nitrogen rich gas) to reduce the oxygen level in the container atmosphere below that of the ambient air and transporting the container while monitoring at least the carbon dioxide and oxygen levels (and preferably also the temperature) within the container and adjusting as necessary, (a) the oxygen content by positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values, (b) the carbon dioxide content by absorbing carbon dioxide from the atmosphere in the container in response to such monitoring towards an optimum or predetermined value or range of values and (c) the temperature, if monitored, by refrigeration in response to such monitoring towards an optimum or predetermined value or range of values.

The present invention recognises that the system disclosed in the aforementioned patent specification can further be improved, in particular in relation to control of the carbon dioxide presence in the container.

It is also recognised that while a system in accordance with the present invention is most appropriate for use with shipping "containers" where there is a wish to obviate the need for the transportation of pressurised or liquefied gases therewith, such a system is equally appropriate in other carriage spaces, eg. the cargo hold of an aircraft, ship, train or the like and therefore for the purposes of the present specification the word "container" as used herein relates not only to shipping containers but to any means defining a storage space for such comestibles.

In a system such as disclosed in the aforementioned patent specification the quantity of carbon dioxide capable of being absorbed is finite where reliance is placed upon a finite amount of a carbon dioxide absorbing medium such as, for example, a scrubbing unit including hydrated lime. Moreover there is also the prospect of carbon dioxide build up where for some reason or another a flow of the gaseous environment of the container can not be ducted through any such carbon dioxide scrubbing device.

It is therefore an object of the present invention to provide a method and related apparatus which will provide some safeguard in the event the carbon dioxide content of the container rises above a desirable level.

Accordingly the present invention, in one aspect, provides a method of transporting a quantity of a comestible which may be subject to degradation as a result of respiration during transportation, comprising the steps of:

(a) sealing or substantially sealing said quantity of the respiring comestible within a container, wherein "container" is defined as any means defining storage space for respiring comestibles, sufficiently to ensure that less oxygen of the ambient air can diffuse into the container than is required for full respiration by the respiring comestible, flushing the container with an oxygen low or oxygen free gas so as to provide a reduced oxygen level in the sealed or substantially sealed container, such flushing occurring before, during and/or after said sealing or substantial sealing, and

(b) transporting the container with the respiring comestible therein while (i) monitoring the oxygen level within said container and automatically adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values and (ii) monitoring the carbon dioxide level within said container and adjusting the carbon dioxide level as necessary in response to such monitoring towards and optimum or predetermined value or range of values without reliance upon flushing with an oxygen low or oxygen free gas, said adjustment being firstly by means of a scrubbing of the air within said container should said carbon dioxide level rise above a first predetermined value, and, secondly, should said carbon dioxide level rise above a second higher predetermined value, by the positive infusion of ambient air into the container.

Preferably said container is refrigerated and there is automatic adjustment of the temperature.

A further aspect of the present invention consists in an apparatus for transporting a quantity of respiring comestibles which may be degraded by respiration, said apparatus comprising:

transportable means defining a volume of a gaseous environment for said comestibles capable of being substantially sealed and in which the comestibles to be transported can be carried;

means to seal or substantially seal said volume after loading with said comestibles such that less

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oxygen from the ambient air can diffuse into the environment than is required for the respiration;

means to enable flushing of the environment with an oxygen free or low gas to reduce the oxygen content thereof below that of ambient air;

means to monitor the oxygen content of the environment;

5   means to monitor the carbon dioxide content of the environment;

means responsive to the means to monitor said oxygen content to cause a positive infusion of ambient air into the environment should the oxygen content be or fall below a predetermined value;

means responsive to the means to monitor said carbon dioxide content to cause passage of gas within the environment through means to scrub at least some of the carbon dioxide therefrom should carbon 10 dioxide content rise above a first predetermined value; and

means responsive to the means to monitor said carbon dioxide content to cause a positive infusion of ambient air into the environment should said carbon dioxide content not be maintained below a higher second predetermined value by said means to scrub at least some carbon dioxide from the environment.

Preferably said apparatus includes means to monitor the temperature of the environment and addition-15 ally means responsive to the means to monitor the temperature of the environment to adjust at least downwardly the temperature of the environment towards a predetermined value.

The environment may be within a container which defines a storage space for respiring comestibles.

A third aspect of the invention provides a gas controller for a container, wherein "container" is defined as any means defining a storage space for respiring comestibles, having means for extraction of CO_2 from 20 the container air and means for exchange of ambient air with container air, said controller comprising:

a microprocessor, read-only memory and read-write memory connected to a common communication bus;

a carbon dioxide detector for monitoring the level of carbon dioxide in the container air;

an oxygen detector for monitoring the level of oxygen in the container air;

25   means for connecting the output of said detectors to said bus; and

an output port connected to said bus for output from said microprocessor of control signals which activate/deactivate said means for extraction and means for exchange;

wherein said microprocessor executes a program stored in said read-only memory which program:

(a) monitors said carbon dioxide and oxygen level;

30   (b) activates/deactivates said means for extraction if said carbon dioxide level rises above/falls below a predetermined carbon dioxide high limit or range of limits;

(c) activates/deactivates said means for exchange if said carbon dioxide level rises above/falls below a predetermined carbon dioxide high limit or range of limits; and

(d) activates/deactivates said means for exchange if said oxygen level falls below/rises above a 35 predetermined oxygen level or range of levels.

One preferred form of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a block diagram of a controller which may be used to implement the present invention; and

Figures 2 and 3 are flow diagrams for portions of the controller microprocessor program.

40   The controller, hereinafter described, is now preferred to be used in connection with the container systems described in the aforementioned specifications, particularly with reference to Figures 1-7 of those specifications, as a replacement for the controller described in relation to Figures 8-10 of those specifications. Such figures and the description thereof is hereby herein incorporated by way of reference.

The controller is a microprocessor based unit which measures, controls, displays and logs levels of 45 carbon dioxide and oxygen in a container as hereinbefore defined, particularly a refrigerated marine shipping container. Control of the gas levels may be achieved via solenoid valves built into the container and connected to the controller. In the case of CO_2, valves are provided to (i) allow passage of container air through a scrubber unit in order to prevent the CO_2 level of the container air rising above a predetermined level, and (ii) allow an infusion of ambient air to the container should the CO_2 level rise above a higher 50 predetermined level, such as in the event of failure of the scrubber action. In the case of O_2, the external valves of (ii) allow an infusion of ambient air to the container in order to prevent the O_2 level of the container air from falling below a predetermined level. The controller is intended to be portable and of a size and shape to fit in the electrical power control box of such containers.

Referring to Figure 1, the controller schematically comprises a microprocessor 1 which operates 55 according to a program stored in read-only memory 2. The microprocessor reads and writes to and from read/write memory 3 and a removable cassette in cassette unit 4. A gas pump 5 continuously draws air from the container through inlet 15 and consecutively through O_2 detector 6 and CO_2 detector 7. Outlet 16 may return the sampled air to the container or its surroundings. A temperature detector 8 monitors

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approximately the temperature of the controller itself. Analog multiplexer 9 passes any of the three detector output signals to analog-to-digital converter 10 in response to commands by the microprocessor. The selected detector signal is then passed to the microprocessor on a common data/address bus 11.

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Microprocessor 1 calculates actual CO_2 and O_2 levels by applying corrections to the detected levels as necessary depending on the detectors used. The CO_2 and O_2 levels according to the most recent sample are then shown on display 12, and may at suitable intervals be stored on the cassette, in addition to the detected temperature and the time according to real time clock 13. The microprocessor compares the actual CO_2 and O_2 levels with predetermined setpoints, these being preferred levels which vary with particular comestibles. Action of the container valves is controlled by the microprocessor.

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It has been practical to group comestibles commonly transported by container into two categories, having preferred CO_2 levels greater or less than 3% by volume of the container air. A high CO_2 limit is defined for each category, above which unacceptable damage to the comestibles occurs. When the preferred level is less than 3% the high limit is 5%, and when the preferred level is greater than 3% the high limit is 5% plus the preferred level.

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That part of the microprocessor program which enacts the present invention will now be described with reference to the flow charts of figures 2 and 3.

In Figure 2, action may be taken in respect of the container CO_2 and O_2 levels, provided that the container is not undergoing defrosting. The microprocessor then proceeds to compare the CO_2 level with the CO_2 setpoint and then with the CO_2 high limit value. If the CO_2 high limit is exceeded, ambient air is

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drawn into the container to lower the container air CO_2 level, otherwise the O_2 level is compared with the O_2 setpoint. CO_2 high limit control thus overrides O_2 level control. In making each comparison and operating valves if necessary, program execution passes to the routine shown in Figure 3.

Referring to Figure 3, the microprocessor calculates an error equal to the deviation of the CO_2 or O_2 level from the corresponding setpoint, and calculates a control value equal to the error magnitude less the

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deadband amplitude. If the control value is negative the error is within the deadband and the existing valve status is maintained. If the control value is positive, the error is outside the deadband and action may be taken as follows. If the CO_2 level and setpoint are being compared, a positive error indicates that the level is undesirably high and the scrubber valve should be opened or remain open, while a negative error indicates that the level is below the setpoint and the scrubber valve should be closed or remain closed. If

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the O_2 level and setpoint are being compared, a positive error indicates that the level is above the setpoint and the external valve should be closed, while a negative error indicates that the level is undesirably low and the external valves should be opened or remain open.

Principal features of a specific embodiment of the invention will now be described. In this embodiment the microprocessor 1 is an Intel 8085 8-bit processor. The other components of the controller shown in

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figure 1 interface with the data/address bus via an 8255 programmable peripheral interface, except that the external ports 15 include an 8251 programmable communications interface for connection of the controller to a further microprocessor if desired. The ROM 2 in which the microprocessor program is stored comprises two 32K 2732 EPROMS while the RAM 3 comprises a 2K 6116 static RAM. The analog multiplexer 9 and analog-to-digital converter 10 comprise 4051 and ADC0802 chips respectively. The

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setpoints for a particular container load are stored in the cassette after input from a portable computer via the 8251 interface as noted above, an the controller cannot exercise the routine of figure 2 unless the cassette is in place. Deadband values (O_2:±0.3%, CO_2:±0.5%) are stored in the EPROMS and are not varied between loads.

A "Teledyne"*type A5 microfuel cell detects oxygen in the container air up to 25% by volume and with

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10% accuracy of reading. The cell output is temperature dependent for which compensation is achieved via a thermistor in the cell output circuit.

A four filament "Gowmac"*thermal conductivity cell is used to detect the presence of carbon dioxide in the container air up to 25% by volume. Each filament of the detector comprises one arm of a resistance bridge, two filaments being used for gas measurement and two filaments for reference. Such a detector is

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not intrinsically CO_2 sensitive but also reflects the O_2 and NO_2 levels of the container air. The microprocessor therefore compensates the conductivity cell output according to the detected O_2 level and an estimate of the N_2 level. The CO_2 detector is also temperature dependent for which further compensation is made by the microprocessor via the output of temperature detector 8. Overall, the CO_2 level obtained with 1%

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* Teledyne Analytical Instruments Box 1580 City of Industry CA 91749 USA

* Gowmac USA Box 32 NJ 08805 USA

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accuracy.

A "Wisa" * vibrator type pump draws container air through the detectors at 0.2-0.5 1/minute. The air is filtered before passage through the CO_2 detector.

Each detector output is read by the microprocessor approximately once every second and a running
5   average for each level is calculated to overcome noise, the detector outputs being compensated as noted previously. The latest averages are displayed on the front panel of the controller and compared with the setpoints. The container CO_2 and O_2 levels and controller temperature are recorded on the cassette approximately every 8 hours when the container and controller are in use. There is provision to monitor and record the temperature within the container through a further communications port in the container, not
10   shown in figure 1, if desired.

Appendix I is a portion of an 8085 assembly language program listing in which lines 222-335 correspond approximately to the flow chart of Figure 2.

Appendix II is a portion of an 8085 assembly language program listing in which lines 1134-1168 carry out CO_2 level compensation for the CO_2 detector temperature, lines 117-1200 carry out CO_2 level
15   compensation in accord with the O_2 level, and lines 1219-1272 correspond approximately to the flow chart of Figure 3.

It is believed that apparatus and methods in accordance with the present invention define widespread application in the transportation industry.

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* Wisa Precision Pumps Bayonne NJ 07002 USA

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APPENDIX 1

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!!S-II 6080/8085 MACRO ASSEMBLER, V4.1              TFCVF
RANSFRESH 300 SERIES CONTROLLER

LOC   OBJ          LINE        SOURCE STATEMENT

00C0 CD0505  C    214         CALL    LOG
00C3 AF           215         XRA     A
00C4 326400  D    216         STA     LOGF    ;AND RESET LOG FLAG
                  217
                  218 ; COMPENSATE AND SCALE INPUTS
00C7 CDA006  C    219 MAIN1:  CALL    TFCMP
                  220
                  221 ; CONTROL OUTPUTS
00CA 3A0430       222         LDA     PORTA
00CD 47 ·         223         MOV     B,A
00CE E620         224         ANI     DFRST   ;DEFROSTING?
00D0 CAA801 ·  C  225         JZ      DPPTR   ;YES, EXIT
                  226
00D3 78           227         MOV     A,B
00D4 E680         228         ANI     CART    ;CARTRIDGE INSERTED
00D6 C2A801  C    229         JNZ     DPPTR   ;NO, EXIT
                  230
                  231 ; DO CONTROL ACTION ON CO2
00D9 110A40       232         LXI     D,ESPCO2 ;GET CO2 SET POINT
00DC CD1E08  C    233         CALL    SPCV    ;CONVERT
                  234
00DF 012300  D    235         LXI     B,TCO2  ;CO2 VALUE
00E2 113300  D    236         LXI     D,TMP   ;SET POINT
00E5 214300  C    237         LXI     H,DBCO2 ;DEADBAND
00E8 3E00         238         MVI     A,0     ;NEGATIVE CONTROL ACTION
00EA CDDB07  C    239         CALL    CTLA
                  240
00ED DA0201  C    241         JC      CON3
00F0 79           242         MOV     A,C
00F1 B7           243         ORA     A
00F2 3A0530       244         LDA     PORTB
00F5 CAFD00  C    245         JZ      CON1
00F8 E6FB    ·    246         ANI     NOT RYCO2
00FA C3FF00  C    247         JMP     CON2
00FD F604         248 CON1:   ORI     RYCO2
00FF 320530       249 CON2:   STA     PORTB
                  250
0102 213300  D    251 CON3:   LXI     H,TMP   ;CLEAR TEMP
0105 0604         252         MVI     B,4
0107 CD0000  E    253         CALL    CLRM
                  254
                  255 ;CHECK CO2 LIMIT
010A 110A40·      256         LXI     D,ESPCO2 ;GET CO2 SET POINT
010D CD1E08  C    257         CALL    SPCV    ;CONVERT
                  258
                  259 ;      SET POINT < 3%
0110 013300  D    260         LXI     B,TMP   ;SET POINT
0113 114F00  C    261         LXI     D,PC3   ;- 3%
0116 213700  D    262         LXI     H,TMP+4
0119 CD0000  E    263         CALL    SUB32
011C 3A3A00  D    264         LDA     TMP+7   ;GET SIGN BIT
011F 0F           265         RRC             ;-VE
0120 DA3501  C    266         JC      CON4    ;YES, SET TO 5%
                  267
                  268 ;      > 3%  SET POINT = SET POINT + 5%
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IIS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
TANSFRESH 300 SERIES CONTROLLER

LOC  OBJ          LINE          SOURCE STATEMENT

0123 013300  D   269           LXI    B,TMP    ;SET POINT =
0126 115300  C   270           LXI    D,PC5    ;SET POINT +
0129 213500  D   271           LXI    H,TMP+5  ;5%
012C CD0000  E   272           CALL   ADD32
012F 115600  D   273           LXI    D,TMP+5  ;-> SETPOINT + 5%
0132 C53801  C   274           JMP    CON5
                 275
                 276  ;         < 5%  SET POINT = 5%
0135 115300  C   277  CON4:    LXI    D,PC5    ;-> 5%
                 278
0138 012300  D   279  CON5:    LXI    B,TCO2   ;-> CO2 COMPENSATED
013B 214B00  C   280           LXI    H,PC1    ;-> DEADBAND
013E 3E00         281           MVI    A,0.     ;CONTROL +VE
0140 CDDB07  C   282           CALL   CTLA
                 283
                 284  ;         DO CONTROL ACTION
0143 DA5801  C   285           JC     CON6     ;ACTION REQUIRED, NO ->
0146 79          286           MOV    A,C      ;ON OR OFF
0147 B7          287           ORA    A
0148 3A0530      288           LDA    PORTB    ;GET PORT
014B CA5301  C   289           JZ     CONA     ;OFF ->
014E E6FD        290           ANI    NOT RYTB ;LIMIT OFF
0150 C35501  C   291           JMP    CONB
0153 F602        292  CONA:    ORI    RYTB     ;LIMIT ON
0155 320530      293  CONB:    STA    PORTB
                 294
0158 3A0530      295  CON6:    LDA    PORTB    ;CHECK LIMIT
015B E602        296           ANI    RYTB     ;LIMIT SET?
015D CA6B01  C   297           JZ     CONC     ;NO, CONT
0160 3A0530      298           LDA    PORTB    ;GET PORT AGAIN
0163 F601        299           ORI    RYO2     ;YES, SET RYO2
0165 320530      300           STA    PORTB
0168 C3A801  C   301           JMP    DPPTR    ;NEXT FUNCTION
                 302
016B 213300  D   303  CONC:    LXI    H,TMP    ;CLEAR TEMP
016E 0608        304           MVI    B,8
0170 CD0000  E   305           CALL   CLRM
                 306
                 307  ;DO CONTROL ACTION ON OXYGEN
0173 110E40      308           LXI    D,ESPO2  ;OXYGEN SET POINT
0176 CD1E08  C   309           CALL   SPCV     ;CONVERT
                 310
                 311  ;POINT TO APPROPIATE O2 CELL FOR CONTROL
0179 210900  D   312           LXI    H,AO2A   ;-> O2A
017C 3A6700  D   313           LDA    O2CF     ;FLAG SET?
017F B7          314           ORA    A
0180 CA8601  C   315           JZ     CON7     ;NO, CONT
                 316
0183 210F00  D   317           LXI    H,AO2B   ;YES POINT TO REF
                 318
0186 44          319  CON7:    MOV    B,H      ;H,L -> O2 VALUE TO USE
0187 4D          320           MOV    C,L      ;TRANSFER TO B,C
0188 113300  D   321           LXI    D,TMP    ;-> O2 SET-POINT
018B 214700  C   322           LXI    H,DBO2   ;-> O2 DEAD BAND
018E 3EFF        323           MVI    A,0FFH
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ISIS-II 8080/8085 MACRO ASSEMBLER, V4.1   TFCVF
:ANSFRESH 300 SERIES CONTROLLER.

```
5      LOC  OBJ           LINE          SOURCE STATEMENT

       0190 CDD507    C   324               CALL    CTLA
                          325
       0193 DAA801    C   326               JC   ·   DPPTR
       0196 79            327               MOV     A,C
10     0197 B7            328               ORA     A
       0198 3A0550        329               LDA     PORTB
       019B CAA301    C   330               JZ      CON3
       019E E6FE ·        331               ANI     NOT RYO2
       01A0 C3A501    C   332               JMP     CON9
       01A3 F601  .       333  CON3:        ORI     RYO2
15     01A5 320550        334  CON9:        STA     PORTB
                          335                  .
                          336 ; SET DISPLAY POINTERS TO CO2 AND O2
       01A8 112300    D   337  DPPTR:  LXI     D,TCO2   ;-> CO2 AVERAGE
       01AB 210800    D   338               LXI     H,AO2A   ;-> O2A AVERAGE
       01AE 3A6900    D   339               LDA     O2CF     ;O2 CONTROL FLAG
20     01B1 B7            340               ORA     A        ;SET?
       01B2 CAB801    C   341               JZ      KPR      ;YES, LEAVE OA2
       01B5 210F00    D   342               LXI     H,AO2B   ;NO, CHANGE TO O2B
                          343
                          344 ; ANY KEYS PRESSED
       01B8 3A6500    D   345  KPR:    .LDA    KEYF
25     01BB B7            346               ORA     A
       01BC CA1F02    C   347               JZ      MAIN3    ;NO, CONT
                          348
                          349 .; NOW SEE WHICH KEY
       01BF 3A0630        350               LDA     PORTC    ;GET KEY
       01C2 E60F          351               ANI     0FH      ;STRIP UPPER
30     01C4 210800    D   352               LXI     H,AO2A   ;-> O2A
       01C7 110F00    D   353               LXI     D,AO2B   ;-> O2B
       01CA FE0D          354               CPI     SWP1     ;O2A & O2B REQUIRED?
       01CC CA0902    C   355               JZ      KPR1    ·;YES, JUMP OUT
       01CF 211300    D   356               LXI     H,AT1    ;NO, -> TEMP 1
       01D2 111700    D   357               LXI     D,AT2    ;-> TEMP 2
35     01D5 FE07          358               CPI     SWP3
       01D7 CA0902    C   359               JZ      KPR1
       01DA 212700    D   360               LXI ·   H,TT4    ;TEMPS 3 & 4
       01DD 111800    D   361               LXI     D,AT3     .
       01E0 FE0B          362               CPI     SWP4
       01E2 CA0902    C   363               JZ      KPR1
40     01E5 B7            364               ORA     A        ;KEY RELEASED?
       01E6 CA0902    C   365               JZ      KPR1     ;YES, EXIT
       01E9 213300 ·  D   366               LXI     H,TMP    ;CLEAR TEMP
       01EC 0608          367               MVI     B,8
       01EE CD0000    E  ··368              CALL    CLRM
       01F1 110E40        369               LXI     D,ESPC2 ;O2 SET POINT
45     01F4 CD1E08    C   370               CALL    SPCV     ;CONVERT
       01F7 3A3400    D   371               LDA     TMP+1    ;GET VALUE
       01FA 323800    D   372               STA     TMP+5
       01FD 110A40        373               LXI     D,ESPCO2 ;O2 SET POINT
       0200 CD1E08    C   374               CALL    SPCV
       0203 213700    D   375               LXI     H,TMP+4
50     0206 113300    D   376               LXI     D,TMP
                          377
                          378 ; KEY PRESSED
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APPENDIX 2

```
IS-II 8080/6085 MACRO ASSEMBLER, V4.1          TFCVF
ANSFRESH 300 SERIES CONTROLLER

LOC   OBJ          LINE          SOURCE STATEMENT

06FF  35           1120          DCR      H
0700  C2B106 · C   1121          JNZ      AVRG
                   1122
0703  3EFF         1123          MVI      A,OFFH   ;SET FIRST TIME FLAG
0705  326A00   D   1124          STA      FIRSTF
                   1125
                   1126 ;NOW COMPENSATE THE AVERAGE VALUES
                   1127 ;EXPAND TEMPERATURE SCALE
0708  011F00   D   1128 TFC2:    LXI      B,AT4    ;AVERAGE TEMP
070B  11B307 · C   1129          LXI      D,THR    ; X 3 =
070E  212700   D   1130          LXI      H,TT4    ;TRUE TEMPERATURE
0711  CD0000   E   1131          CALL     MUL32
                   1132
                   1133 ;COMPENSATE CO2 FOR TEMPERATURE
0714  012700   D   1134          LXI      B,TT4    ;DELTA T
0717  11CB07   C   1135          LXI      D,K4
071A  213D00   D   1136          LXI      H,TMP1
071D  CD0000   E   1137          CALL     SUB32
                   1138
0720  013D00   D   1139          LXI      B,TMP1   ;DELTA T X 200
0723  11CF07   C   1140          LXI      D,K5
0726  213500   D   1141          LXI      H,TMP
0729  CD0000   E   1142          CALL     MUL32
                   1143
072C  010700   D   1144          LXI      B,ACO2   ;CO2A X 1000
072F  11D307   C   1145          LXI      D,K6
0732  212300   D   1146          LXI      H,TCO2
0735  CD0000   E   1147          CALL     MUL32
                   1148
0738  012300   D   1149          LXI      B,TCO2   ;(CO2A X 1000)
073B  113300   D   1150          LXI      D,TMP    ;- ((TT4 - 64000) X 200)
073E  212300   D   1151          LXI      H,TCO2
0741  CD0000   E   1152          CALL     SUB32
                   1153
0744  013500   D   1154          LXI      B,TMP1   ;(TT4 - 64000)/569
0747  11D707   C   1155          LXI      D,K7
074A  213D00   D   1156          LXI      H,TMP1
074D  CD0000   E   1157          CALL     DIV32
                   1158
0750  01D307   C   1159          LXI      B,K6     ;1000 - (DELTA T - 64000)
0753  113D00   D   1160          LXI      D,TMP1   ;---------------------
0756  213D00   D   1161          LXI      H,TMP1   ;         569
0759  CD0000 · E   1162          CALL     SUB32
                   1163
075C  012300   D   1164          LXI      B,TCO2   ;A - 0.2(DELTA T)
075F  113D00   D   1165          LXI      D,TMP1   ;-----------------
0762  212300   D   1166          LXI      H,TCO2   ; 1 - 0.0045(DELTA T)
0765  CD0000   E   1167          CALL     DIV32
                   1168
                   1169 ;COMPENSATE CO2 FOR O2 CONCENTRATION
0768  010B00   D   1170          LXI      B,AO2A   ;-> O2A
076B  3A6900   D   1171          LDA      O2CF     ;GET APPROPRIATE
076E  B7           1172          ORA      A        ;O2 READING
076F  CA7507   C   1173          JZ       AVG1
0772  010F00   D   1174          LXI      B,AO2B
```

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3IS-II 6080/8065 MACRO ASSEMBLER, V4.1          TFCVF
RANSFRESH 300 SERIES CONTROLLER

     LOC  OBJ          LINE           SOURCE STATEMENT

                       1175
                       1176 ;COMPENSATE CO2 DATA
     0775 115307   C   1177 AVG1:  LXI     D,TEN       ;C2 / 10
     0778 213000   D   1178        LXI     H,TMP1
     077B CD0000   E   1179        CALL    DIV32
                       1180
     077E 012300   D   1181        LXI     B,TCO2      ;CO2 + O2/10
     0781 113000   D   1182        LXI     D,TMP1
     0784 213000   D   1183        LXI     H,TMP1
     0787 CD0000 . E   1184        CALL    ADD32
                       1185
     078A 013000   D   1186        LXI     B,TMP1      ;(CO2 + O2/10) - 2(UNITS)
     078D 11AF07   C   1187        LXI     D,TWOU
     0790 213000   D   1188        LXI     H,TMP1
     0793 CD0000   E . 1189        CALL    SUB32
                       1190
     0796 013000   D   1191        LXI     B,TMP1      ;(CO2 - 2 + O2/10)
     0799 11B707   C   1192        LXI     D,NINE      ;-------------------
     079C 213000   D   1193        LXI     H,TMP1      ;        9
     079F CD0000   E   1194        CALL    DIV32
                       1195
     07A2 013000   D   1196        LXI     B,TMP1      ;(CO2 - 2 + O2/10) X 10/9
     07A5 11BB07   C   1197        LXI     D,TEN
     07A8 212300   D   1198        LXI     H,TCO2
     07AB CD0000   E   1199        CALL    MUL32
                       1200
     07AE C9            1201        RET
                       1202
     07AF 7C14         1203 TWOU:  DW      5244,0      ;TWO (UNITS)
     07B1 0000
     07B3 0300         1204 THR:   DW      3,0         ;THREE
     07B5 0000
     07B7 0900         1205 NINE:  DW      9,0         ;NINE
     07B9 0000
     07BB 0A00         1206 TEN:   DW      10,0        ;TEN
     07BD 0000
     07BF ED17         1207 K1:    DW      6125,0      ;CONSTANT 1
     07C1 0000
     07C3 3958         1208 K2:    DW      22585,0     ;CONSTANT 2
     07C5 0000
     07C7 1000         1209 K3:    DW      16,0        ;CONSTANT 3
     07C9 0000
     07CB 00FA         1210 K4:    DW      64000,0     ;CONSTANT 4
     07CD 0000
     07CF 1400         1211 K5:    DW      20,0        ;CONSTANT 5
     07D1 0000
     07D3 E803         1212 K6:    DW      1000,0      ;CONSTANT 6
     07D5 0000
     07D7 3902         1213 K7:    DW      569,0       ;CONSTANT 7
     07D9 0000
                       1214
                       1215 ;**********************************************
                       1216
                       1217 ;CLTA:-         CONTROL ACTION SUBROUTINE
                       1218
```

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IIS-II 8080/8085 MACRO ASSEMBLER, V4.1              TFCVF
TANSFRESH 300 SERIES CONTROLLER

LOC   CBJ         LINE         SOURCE STATEMENT

                  1219 ;ENTER: BC -> INPUT VARIABLE
                  1220 ;       DE -> SET-POINT VALUE
                  1221 ;       HL -> DEADBAND VALUE
                  1222 ;       A = CONTROL ACTION, 00=+VE, FF=-VE
                  1223
                  1224 ;EXIT: CARRY, NO ACTION ERROR<DEDBAND
                  1225 ;       C = ACTION 00(OFF), FF(ON).
                  1226
                  1227 ;------------------------------------------------.
                  1228
07DB FS           1229 CTLA:   PUSH   PSW      ;SAVE ACTION
07DC ES           1230         PUSH   H        ;SAVE DEADBAND POINTER
                  1231
                  1232         ;ENTER3 WITH BC, DE SET
07DD 213300  D    1233         LXI    H,TMP    ;ERROR
07E0 CD0000  E    1234         CALL   SUB32
                  1235
07E3 AF           1236         XRA    A        ;RESET
07E4 326800  D    1237         STA    NEGF     ;NEGATIVE FLAG
                  1238
07E7 213600  D    1239         LXI    H,TMP+3
07EA 7E           1240         MOV    A,M      ;ERROR -VE?
07EB 07           1241         RLC
07EC D2FA07  C    1242         JNC    3+14     ;NO, ->
07EF 3EFF         1243         MVI    A,OFFH   ;YES,
07F1 326800  D    1244         STA    NEGF     ;NEGATIVE FLAG
07F4 213300  D    1245         LXI    H,TMP
07F7 CD0000  E    1246         CALL   COMPHL   ;MAKE POSITIVE
                  1247
07FA 013300  D    1248         LXI    B,TMP    ;ERROR
07FD D1           1249         POP    D        ;DEADBAND
07FE 213300  D    1250         LXI    H,TMP    ;Control Required
0801 CD0000  E    1251         CALL   SUB32
                  1252
0804 3A3600  C    1253         LDA    TMP+3    ;ERROR < DEADBAND?
0807 07           1254         RLC
0808 C1           1255         POP    B
0809 D8           1256         RC              ;ERROR < DEADBAND, RETURN
080A 78           1257         MOV    A,B
080B B7           1258         ORA    A        ;ACTION + OR -
080C CA1108  C    1259         JZ     3+5      ;ACTION +,RETURN WITH 00H
080F 3EFF         1260         MVI    A,OFFH   ;ACTION -,RETURN WITH OFFH
0811 4F           1261         MOV    C,A      ;PUT ACTION IN C
                  1262
0812 3A6800  D    1263         LDA    NEGF     ;WAS ERROR -VE?
0815 B7           1264         ORA    A
0816 CA1C08  C    1265         JZ     3+6      ;NO, ->
0819 79           1266         MOV    A,C
081A 2F           1267         CMA
081B 4F           1268         MOV    C,A
                  1269
081C AF           1270         XRA    A        ;CLEAR ACTION FLAG
081D C9           1271         RET
                  1272
                  1273 ;------------------------------------------------
```

Claims

1. A method of transporting a quantity of a comestible which may be subject to degradation as a result of respiration during transportation, comprising the steps of:
    (a) sealing or substantially sealing said quantity of the respiring comestible within a container, wherein 'container' is defined as any means defining storage space for respiring comestibles, sufficiently to ensure that less oxygen of the ambient air can diffuse into the container than is

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required for full respiration by the respiring comestible, flushing the container with an oxygen low or oxygen free gas so as to provide a reduced oxygen level in the sealed or substantially sealed container, such flushing occurring before, during and/or after said sealing or substantial sealing, and
(b) transporting the container with the respiring comestible therein while (i) monitoring the oxygen level within said container and automatically adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values and (ii) monitoring the carbon dioxide level within said container and adjusting the carbon dioxide level as necessary in response to such monitoring towards and optimum or predetermined value or range of values without reliance upon flushing with an oxygen low or oxygen free gas, said adjustment being firstly by means of a scrubbing of the air within said container should said carbon dioxide level rise above a first predetermined value, and, secondly, should said carbon dioxide level rise above a second higher predetermined value, by the positive infusion of ambient air into the container.

2. A method as claimed in claim 1 wherein said container is refrigerated and there is automatic adjustment of the temperature.

3. Apparatus for transporting a quantity of respiring comestibles which may be degraded by respiration, said apparatus comprising:
transportable means defining a volume of a gaseous environment for said comestibles capable of being substantially sealed and in which the comestibles to be transported can be carried;
means to seal or substantially seal said volume after loading with said comestibles such that less oxygen from the ambient air can diffuse into the environment then is required for the respiration;
means to enable flushing of the environment with an oxygen free or low gas to reduce the oxygen content thereof below that of ambient air;
means to monitor the oxygen content of the environment;
means to monitor the carbon dioxide content of the environment;
means responsive to the means to monitor said oxygen content to cause a positive infusion of ambient air into the environment should the oxygen content be or fall below a predetermined value;
means responsive to the means to monitor said carbon dioxide content to cause passage of gas within the environment through means to scrub at least some of the carbon dioxide therefrom should said carbon dioxide content rise above a first predetermined value; and
means responsive to the means to monitor said carbon dioxide content to cause a positive infusion of ambient air into the environment should said carbon dioxide content not be maintained below a higher second predetermined value by said means to scrub at least some carbon dioxide from the environment.

4. Apparatus as claimed in claim 3 wherein said environment is within a container which defines a storage space for respiring comestibles.

5. Apparatus as claimed in claim 3 wherein there is provided means to monitor the temperature of the environment and additionally means responsive to the means to monitor the temperature of the environment to adjust at least downwardly the temperature of the environment towards a predetermined value.

6. A gas controller for a container, wherein "container" is defined as any means defining a storage space for respiring comestibles, having means for extraction of CO_2 from the container air and means for exchange of ambient air with container air, said controller comprising:
a microprocessor, read-only memory and read-write memory connected to a common communication bus;
a carbon dioxide detector for monitoring the level of carbon dioxide in the container air;
an oxygen detector for monitoring the level of oxygen in the container air;
means for connecting the output of said detectors to said bus; and
an output port connected to said bus for output from said microprocessor of control signals which activate/deactivate said means for extraction and means for exchange;
wherein said microprocessor executes a program stored in said read-only memory which program:
(a) monitors said carbon dioxide and oxygen level;

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(b) activates/deactivates said means for extraction if said carbon dioxide level rises above/falls below a predetermined carbon dioxide level or range of levels;

(c) activates/deactivates said means for exchange if said carbon dioxide level rises above/falls below a predetermined carbon dioxide high limit or range of limits exceeding said carbon dioxide level or range of levels; and

(d) activates/deactivates said means for exchange if said oxygen level falls below/rises above a predetermined oxygen level or range of levels.

7. A gas controller according to claim 6 wherein said activation/deviation comprises opening/closing of solenoid valves.

8. A gas controller according to claim 6 or claim 7 wherein said predetermined levels are preferred levels for transport of respiring comestibles within said container.

9. A gas controller according to any one of claims 6 to 8 wherein said predetermined carbon dioxide limit is a limit above which unacceptable damage occurs to comestibles being transported in said container.

10. A gas controller according to any one of claims 6 to 9 wherein said means for connecting the output of said detectors to said bus comprises an analog multiplexer in series with an analog-to-digital converter.

11. A gas controller according to any one of claims 6 to 10 wherein said program records at predetermined intervals said carbon dioxide an oxygen levels in a removable memory element connected to said microprocessor via said bus.

Patentansprüche

1. Verfahren zum Transport einer Menge eines Lebensmittels, das sich während des Transports infolge Atmung zersetzen kann, umfassend die folgenden Schritte:

(a) die Menge des atmenden Lebensmittels in einem Behälter dicht oder im wesentlichen dicht verschließen, wobei "Behälter" definiert ist als jede Einrichtung, die einen Lagerraum für atmende Lebensmittel aufweist, der mit hinreichender Sicherheit gewährleistet, daß weniger Sauerstoff aus der Umgebungsluft in den Behälter eindringen kann als von dem atmenden Lebensmittel zur vollständigen Atmung benötigt wird, Spülen des Behälters mit einem sauerstoffarmen oder sauer-stofffreien Gas, so daß in dem dicht oder im wesentlichen dicht verschlossenen Behälter ein verminderter Sauerstoffgehalt erreicht wird, wobei das Spülen vor, während und/oder nach dem dichten oder im wesentlichen dichten Verschließen erfolgt, und

(b) Transportieren des Behälters mit dem darin enthaltenen atmenden Lebensmittel, während (i) der Sauerstoffgehalt in dem Behälter überwacht und der Sauerstoffgehalt nach Bedarf entsprechend dieser Überwachung durch zwangsläufiges Einleiten von Umgebungsluft in den Behälter automatisch auf einen optimalen oder vorbestimmten Wert oder Wertebereich reguliert wird, und (ii) Überwachen des Kohlendioxidgehalts in dem Behälter und Regulieren des Kohlendioxidgehalts nach Bedarf entsprechend dieser Überwachung auf einen optimalen oder vorbestimmten Wert oder Wertebe-reich, ohne daß zu diesem Zweck mit einem sauerstoffarmen oder sauerstofffreien Gas gespült wird, wobei die Regulierung zunächst durch Waschen der in dem Behälter befindlichen Luft erfolgt, wenn der Kohlendioxidgehalt über einen ersten vorbestimmten Wert ansteigt, und zweitens, wenn der Kohlendioxidgehalt über einen zweiten höheren vorbestimmten Wert ansteigt, durch zwangsläufiges Einleiten von Umgebungsluft in den Behälter.

2. Verfahren nach Anspruch 1, bei dem der Behälter gekühlt wird und eine automatische Temperaturrege-lung erfolgt.

3. Verfahren zum Transport einer Menge atmender Lebensmittel, die sich durch Atmung zersetzen können, wobei die Vorrichtung folgendes umfaßt:

eine transportable Einrichtung, die ein Volumen einer gasförmigen Umgebung für die Lebensmittel aufweist, das im wesentlichen dicht verschlossen werden kann, und in dem die zu transportierenden Lebensmittel getragen werden können;

eine Einrichtung, mit der das Volumen bzw. der Hohlraum nach dem Beschicken mit den Lebensmitteln dicht oder im wesentlichen dicht verschlossen wird, so daß weniger Sauerstoff aus der Umgebungsluft

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in den Hohlraum eindringen kann als für die Atmung erforderlich ist;
eine Einrichtung, mit der der Hohlraum mit einem sauerstofffreien oder sauerstoffarmen Gas gespült werden kann, um seinen Sauerstoffgehalt unter den der Umgebungsluft abzusenken;
eine Einrichtung zur Überwachung des Sauerstoffgehalts in dem Hohlraum;

5   eine Einrichtung zur Überwachung des Kohlendioxidgehalts in dem Hohlraum;
eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung des Sauerstoffgehalts eine zwangsläufige Einleitung von Umgebungsluft in den Hohlraum veranlaßt, wenn der Sauerstoffgehalt einen vorbestimmten Wert besitzt oder unter diesen abfällt;
eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung des Kohlendioxidgehalts

10   Gas in dem Hohlraum durch die Einrichtung strömen läßt, um wenigstens etwas von dem Kohlendioxid herauszuwaschen, wenn der Kohlendioxidgehalt über einen ersten vorbestimmten Wert ansteigt; und
eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung des Kohlendioxidgehalts eine zwangsläufige Einleitung von Umgebungsluft in den Hohlraum veranlaßt, wenn der Kohlendioxid-gehalt von der Einrichtung, die wenigstens etwas von dem Kohlendioxid aus dem Hohlraum heraus-

15   wäscht, nicht unter einem höheren zweiten vorbestimmten Wert gehalten wird.

4. Vorrichtung nach Anspruch 3, bei der der Hohlraum sich in einem Behälter befindet, der einen Lagerraum für atmende Lebensmittel aufweist.

20 5. Vorrichtung nach Anspruch 3, bei der eine Einrichtung zur Überwachung der Temperatur in dem Hohlraum vorgesehen ist und außerdem eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung der Temperatur in dem Hohlraum die Temperatur in dem Hohlraum wenigstens nach unten auf einen vorbestimmten Wert reguliert.

25 6. Gasregler für einen Behälter, wobei "Behälter" definiert ist als jede Einrichtung, die eine Lagerraum für atmende Lebensmittel aufweist, umfassend eine Einrichtung zum Extrahieren von CO_2 aus der Behälterluft und eine Einrichtung zum Austausch von Umgebungsluft mit Behälterluft, wobei der Regler folgendes umfaßt:
einen Mikroprozessor, einen Nur-Lese-Speicher und einen Schreib-Lese-Speicher, die mit einem

30   gemeinsamen Datenübertragungsbus verbunden sind;
eine Kohlendioxiddetektor zur Überwachung des Kohlendioxidgehalts in der Behälterluft;
einen Sauerstoffdetektor zur Überwachung des Sauerstoffgehalts in der Behälterluft;
eine Einrichtung, die den Ausgang der Detektoren mit dem Bus verbindet; und
einen Ausgabebaustein, der mit dem Bus verbunden ist, um von dem Mikroprozessor Steuersignale

35   abzusetzen, die die Extraktionseinrichtung und die Austauscheinrichtung aktivieren bzw. deaktivieren;
wobei der Mikroprozessor ein Programm ausführt, das in dem Nur-Lese-Speicher gespeichert ist, wobei das Programm
a) den Kohlendioxidgehalt und den Sauerstoffgehalt überwacht;
b) die Extraktionseinrichtung aktiviert bzw. deaktiviert, wenn der Kohlendioxidgehalt einen vorbe-

40   stimmten Wert oder Wertebereich übersteigt oder unter diesen abfällt;
c) die Austauscheinrichtung aktiviert bzw. deaktiviert, wenn der Kohlendioxidgehalt einen vorbe-stimmten Höchstwert oder Grenzwertbereich für den Kohlendioxidgehalt übersteigt oder unter diesen abfällt, der höher ist als der genannte Wert oder Wertebereich; und
d) die Austauscheinrichtung aktiviert bzw. deaktiviert, wenn der Sauerstoffgehalt unter einen vorbe-

45   stimmten Wert oder Wertebereich absinkt oder diesen übersteigt.

7. Gasregler nach Anspruch 6, bei dem das Aktivieren/Deaktivieren das Öffnen/Schließen von Magnetven-tilen umfaßt.

50 8. Gasregler nach Anspruch 6 oder Anspruch 7, bei dem die vorbestimmten Werte bevorzugte Werte für den Transport atmender Lebensmittel in dem Behälter sind.

9. Gasregler nach einem der Ansprüche 6 bis 8, bei dem der vorbestimmte Kohlendioxidgrenzwert ein Grenzwert ist, über dem die in dem Behälter transportierten Lebensmittel in inakzeptabler Weise

55   beschädigt werden.

10. Gasregler nach einem der Ansprüche 6 bis 9, bei dem die Einrichtung zum Verbinden des Ausgangs der Detektoren mit dem Bus einen Analogmultiplexer umfaßt, der mit einem A/D-Wandler in Reihe

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geschaltet ist.

11. Gasregler nach einem der Ansprüche 6 bis 10, bei dem das Programm in vorbestimmten Abständen den Kohlendioxid- und Sauerstoffgehalt in ein herausnehmbares Speicherelement schreibt, das über
5 den Bus mit dem Mikroprozessor verbunden ist.

Revendications

1. Procédé de transport d'une quantité d'un produit comestible pouvant être sujet à altération en résultat
10 d'une respiration durant le transport, comportant les étapes consistant à:
(a) enfermer hermétiquement ou sensiblement hermétiquement ladite quantité du produit comestible respirant à l'intérieur d'un récipient, ledit "récipient" étant défini comme étant un moyen quelconque délimitant une chambre de stockage pour des produits comestibles respirants, suffisamment pour assurer que moins d 'oxygène de l'air ambiant que la quantité nécessaire pour une respiration
15 complète du produit comestible respirant puisse diffuser dans le récipient, balayer le récipient avec un gaz pauvre en oxygène ou sans oxygène de manière à assurer un taux d'oxygène réduit dans le récipient hermétique ou sensiblement hermétique, un tel balayage se produisant avant, durant et/ou après ledit enfermement hermétique ou sensiblement hermétique, et
(b) transporter le récipient contenant le produit comestible respirant tout en (i) contrôlant le taux
20 d'oxygène à l'intérieur dudit récipient et en réglant automatiquement le taux d'oxygène nécessaire par une injection positive d'air ambiant dans le récipient en réponse à ce contrôle vers une valeur ou fourchette de valeurs optimal ou prédéterminée et (ii) en contrôlant le taux de gaz carbonique à l'intérieur dudit récipient et en réglant le taux de gaz carbonique nécessaire en réponse à ce contrôle vers une valeur ou une fourchette de valeurs optimal ou prédéterminée indépendamment
25 du balayage par un gaz pauvre en oxygène ou sans oxygène, ledit réglage étant tout d'abord effectué par épuration de l'air à l'intérieur dudit récipient au cas où ledit taux de gaz carbonique s'élève au-dessus d'une première valeur prédéterminée, et,en second lieu, au cas où ledit taux de gaz carbonique s'élève au-dessus d'une seconde valeur prédéterminée supérieure, par l'injection positive d'air ambiant dans le récipient.
30
2. Procédé selon la revendication 1, dans lequel ledit récipient est réfrigéré et possède un réglage automatique de la température.

3. Dispositif de transport d'une quantité de produits comestibles respirants pouvant être altérés par
35 respiration, ledit dispositif comportant:
des moyens transportables délimitant un volume d'environnement gazeux pour lesdits produits comestibles pouvant être fermé pratiquement hermétiquement,et dans lesquels les produits comestibles devant être transportés peuvent être contenus;
des moyens pour fermer hermétiquement ou sensiblement hermétiquement ledit volume après
40 chargement desdits produits comestibles de telle sorte que moins d'oxygène de l'air ambiant que la quantité nécessaire pour la respiration puisse diffuser dans l'environnement ;
des moyens permettant un balayage de l'environnement avec un gaz pauvre en oxygène ou sans oxygène pour réduire la teneur en oxygène de celui-ci au-dessous de celle de l'air ambiant;
des moyens pour contrôler la teneur en oxygène de l'environnement;
45 des moyens pour contrôler la teneur en gaz carbonique de l'environnement;
des moyens sensibles aux moyens pour contrôler la teneur en oxygène pour provoquer une injection positive d'air ambiant dans l'environnement au cas où la teneur en oxygène est ou tombe au-dessous d'une valeur prédéterminée;
des moyens sensibles aux moyens pour contrôler ladite teneur en gaz carbonique pour provoquer
50 un passage de gaz à l'intérieur de l'environnement à travers des moyens d'épuration d'au moins une partie du gaz carbonique de ceux-ci au cas où ladite teneur en gaz carbonique s'élève au-dessus d'une première valeur prédéterminée; et
des moyens sensibles aux moyens pour contrôler ladite teneur en gaz carbonique pour provoquer une injection positive d'air ambiant dans l'environnement au cas où ladite teneur en gaz carbonique
55 n'est pas maintenue au-dessous d'une seconde valeur prédéterminée supérieure par lesdits moyens d'épuration d'au moins une partie du gaz carbonique de l'environnement.

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4. Dispositif selon la revendication 3, dans lequel ledit environnement se trouve à l'intérieur d'un récipient délimitant une chambre de stockage pour des produits comestibles respirants.

5. Dispositif selon la revendication 3, dans lequel sont prévus des moyens pour contrôler la température de l'environnement et de plus des moyens sensibles aux moyens contrôlant la température de l'environnement pour régler au moins à la baisse la température de l'environnement vers une valeur prédéterminée.

6. Contrôleur de gaz pour un récipient, dans lequel ledit "récipient" est défini comme étant un moyen quelconque délimitant une chambre de stockage pour des produits comestibles respirants, possédant des moyens pour une extraction de CO_2 de l'air du récipient et des moyens d'échange d'air ambiant avec l'air du récipient, ledit contrôleur comportant:
   un microprocesseur, une mémoire morte et une mémoire de lecture-écriture connectés à un bus de communication commun;
   un détecteur de gaz carbonique pour contrôler le taux de gaz carbonique dans l'air du récipient;
   un détecteur d'oxygène pour contrôler le taux d'oxygène dans l'air du récipient;
   des moyens pour relier la sortie desdits détecteurs audit bus; et
   un point de connexion de sortie relié audit bus pour une délivrance depuis ledit microprocesseur de signaux de commande qui activent/désactivent lesdits moyens d'extraction et lesdits moyens d'échange:
   dans lequel ledit microprocesseur exécute un programme mémorisé dans ladite mémoire morte, lequel programme:
   (a) contrôle ledit taux de gaz carbonique et d'oxygène;
   (b) active/désactive lesdits moyens d'extraction si ledit taux de gaz carbonique s'élève au-dessus de/s'abaisse au-dessous d'une limite ou fourchette de limites de gaz carbonique prédéterminées;
   c) active/désactive lesdits moyens d'échange si ledit taux de gaz carbonique s'élève au-dessus de / s'abaisse au-dessous d'une limite ou fourchette de limites supérieure de gaz carbonique prédéterminées dépassant ladite limite ou fourchette de limites de gaz carbonique.
   d) active/désactive lesdits moyens d'échange si ledit taux d'oxygène tombe au-dessous/s'élève au-dessus d'un taux ou d'une fourchette de taux d'oxygène prédéterminés.

7. Contrôleur de gaz selon la revendication 6, dans lequel ladite activation/désactivation comporte l'ouverture/fermeture d'électro-vannes.

8. Contrôleur de gaz selon la revendication 6 ou la revendication 7, dans lequel lesdits taux prédéterminés sont des taux préférés pour un transport de produits comestibles respirants à l'intérieur dudit récipient.

9. Contrôleur de gaz selon l'une quelconque des revendications 6 à 8, dans lequel ladite limite prédéterminée de gaz carbonique est une limite au-dessus de laquelle une détérioration inadmissible est provoquée pour des produits comestibles transportés dans ledit récipient.

10. Contrôleur de gaz selon l'une quelconque des revendications 6 à 9, dans lequel lesdits moyens reliant la sortie desdits détecteurs audit bus comportent un multiplexeur analogique en série avec un convertisseur analogique-numérique.

11. Contrôleur de gaz selon l'une quelconque des revendications 6 à 10, dans lequel ledit programme enregistre à des intervalles prédéterminés lesdits taux de gaz carbonique et d'oxygène dans un élément de mémoire amovible connecté audit microprocesseur par l'intermédiaire dudit bus
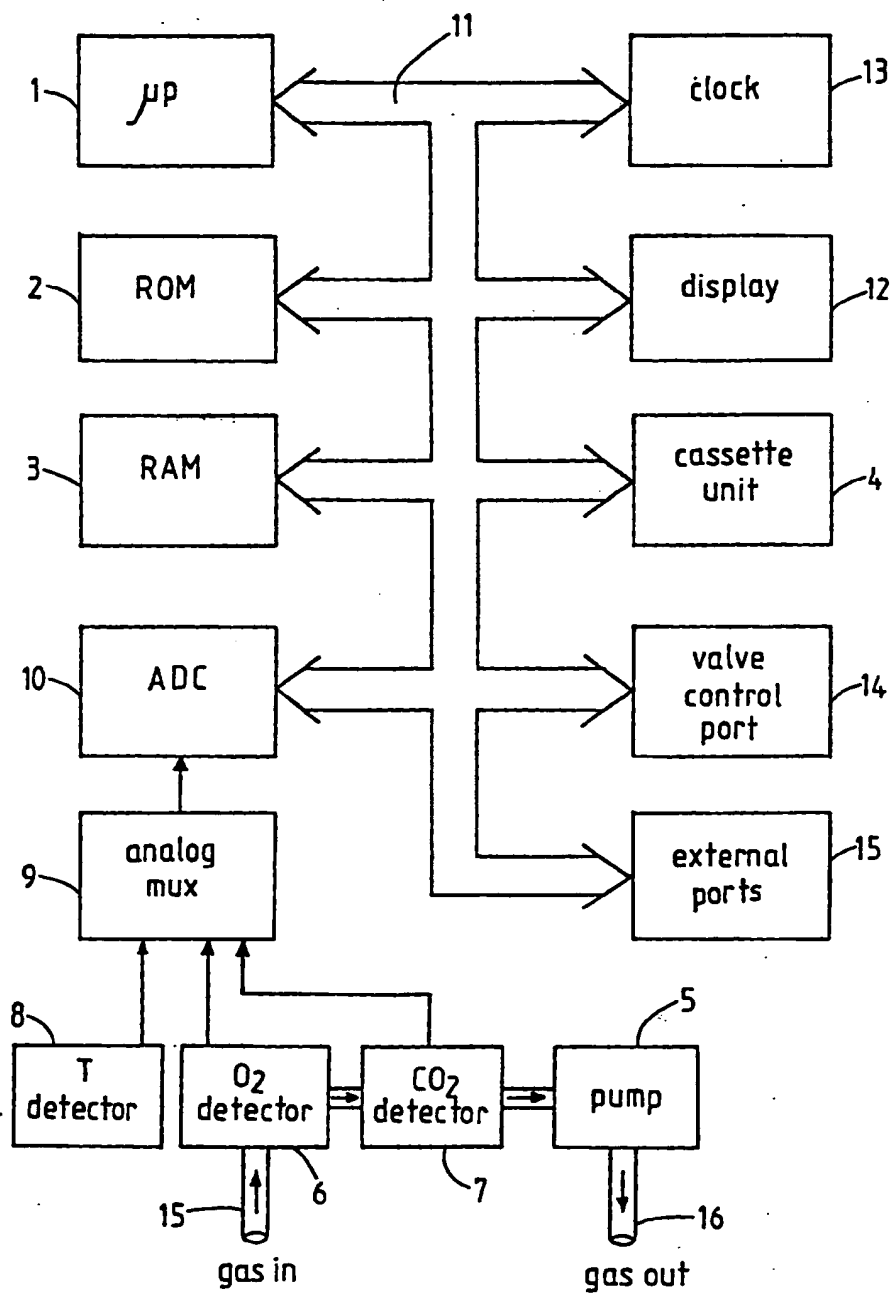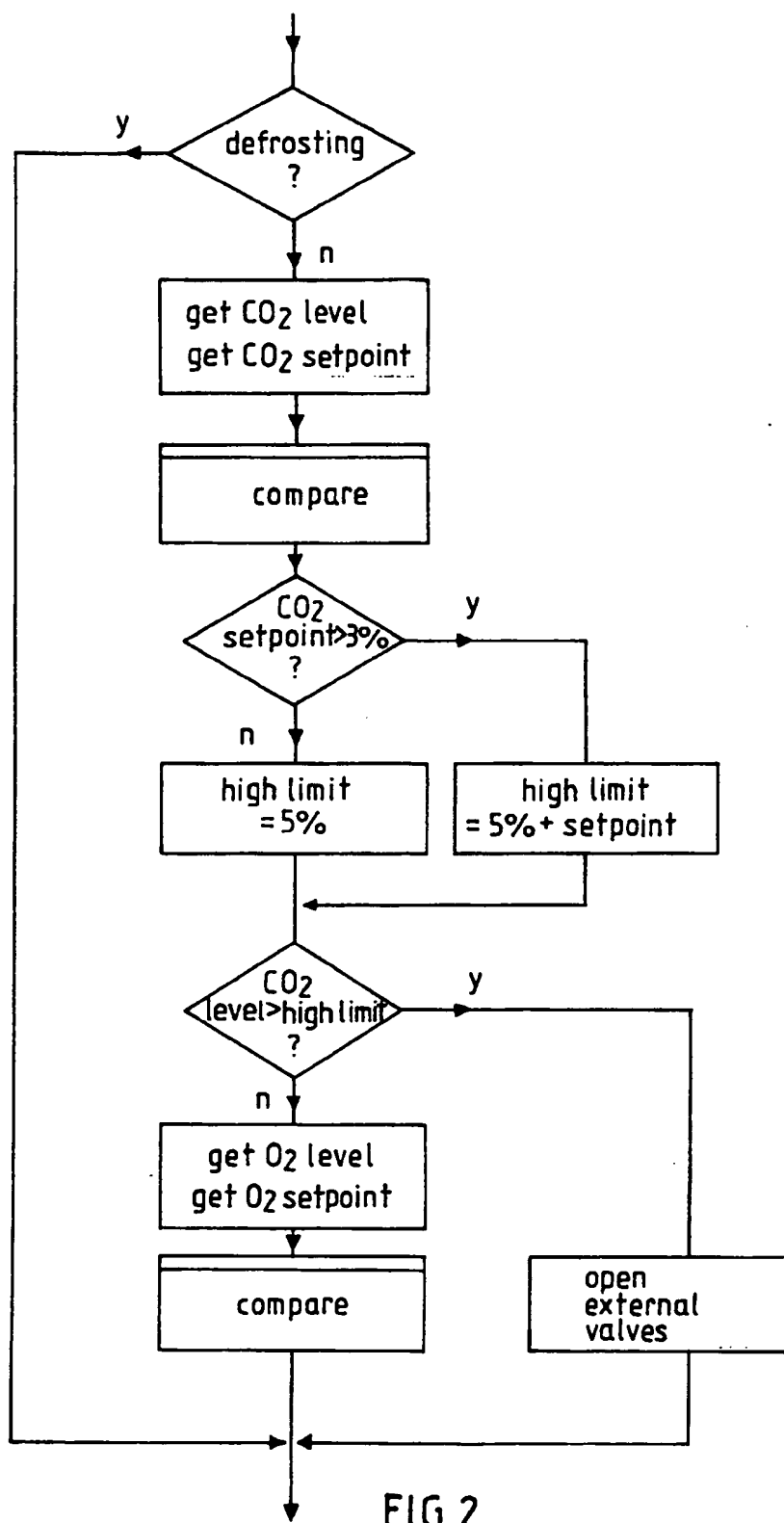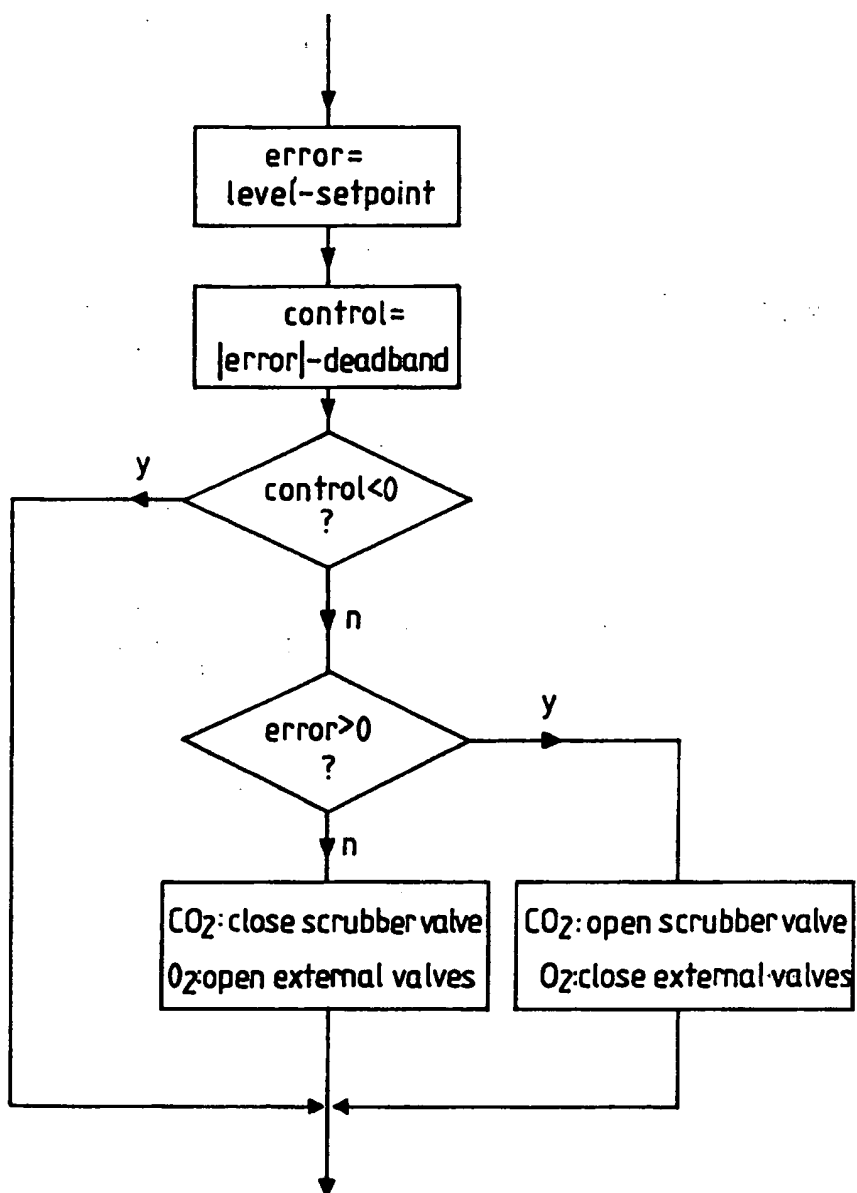
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FIG.1

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FIG.2

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```
              │
              ▼
      ┌───────────────┐
      │    error=     │
      │ level-setpoint│
      └───────────────┘
              │
              ▼
      ┌───────────────┐
      │   control=    │
      │ |error|-deadband│
      └───────────────┘
              │
              ▼
  y        �◊
◄──────── control<0
              ?
              │ n
              ▼
          ◇ error>0 ◇ ──────── y
              ?
              │ n
              ▼                      ▼
  ┌────────────────────┐  ┌────────────────────┐
  │ CO₂:close scrubber valve│ CO₂: open scrubber valve│
  │ O₂:open external valves│ O₂:close external·valves│
  └────────────────────┘  └────────────────────┘
```

$$error = level-setpoint$$

$$control = |error|-deadband$$

control<0 ?

error>0 ?

CO_2: close scrubber valve
O_2: open external valves

CO_2: open scrubber valve
O_2: close external valves

FIG. 3